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INDEX TO BENET LABORATORIES TECHNICAL REPORTS - 1989

R. D. NEIFELD

TECHNICAL PUBLICATIONS AND EDITING SECTION

JULY 1990

US ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
CLOSE COMBAT ARMAMENTS CENTER
BENÉT LABORATORIES
WATERVLIET, N.Y. 12189-4050

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REPORT DOCUMENTATION PAGE

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Benet Laboratories
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Bibliography
Abstracts
Document Control Data

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report consists of
This is a compilation of technical reports published by Benet Laboratories during 1989.

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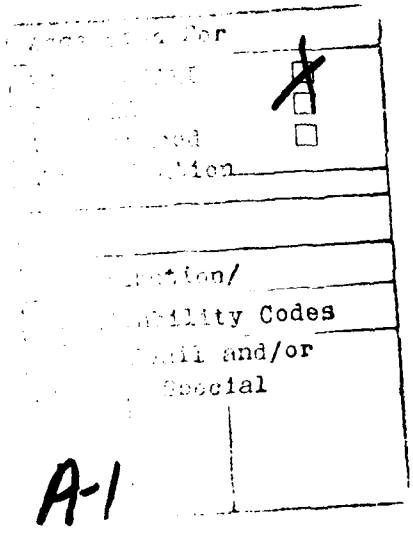

TECHNICAL REPORTS 1989

REPORT NUMBER	TITLE	AUTHOR	DATE
ARCCB-TR-89001	Machine Tool Dynamic Measurements and Diagnostic System	R.K. Wharton T.P. Vincent	Jan 89
ARCCB-TR-89002	High Speed Abrasive Belt Grinding	J. Bak	Jan 89
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ARCCB-CR-89007	Propellant Driven MHD Generator for Rail Gun Power Supply	G.W. Shuy J.T. Woo P.M. Vottis (Benet Labs)	Mar 89
ARCCB-TR-89008	Wave Coupling and Resonance in Gun Tubes	T.E. Simkins	Mar 89
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ARCCB-TR-89010	Switching Zone Control as a Distributed Controller	R.L. Racicot S.S.L. Chang	Apr 89
ARCCB-MR-89011	Dimensional Changes in Wires During Coiling Operations	B. Avitzur	May 89
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ARCCB-MR-89015	Report on the Development of Non-destructive Testing Criteria for the 120-mm XM830 Projectile Body	J.A. Kapp R.T. Abbott	June 89
ARCCB-TR-89016	Fracture and Three-Dimensional Stress Analyses of 7075 Aluminum Projectile Components Under Spin and Inertia Load	J.H. Underwood M.A. Scavullo G.P. O'Hara B.A. Konrad	Jun 89
ARCCB-TR-89017	Compression Molding of Fiber Glass/ Epoxy Handguards for the SFLM Advanced Combat Rifle	K.R. Miner	Jul 89
ARCCB-TR-89018	Applications and Limitations of Finite Element Analysis to Armament Components	J.H. Underwood	Jul 89
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ARCCB-TR-89020	The Influence of Transient Flexural Waves on Dynamic Strains in Gun Tubes	T.E. Simkins	Aug 89
ARCCB-TR-89021	Effects of Varying Plating Parameters on the Longitudinal Distribution of Low Contraction Chromium in Long Gun Tubes	J.C. Askew	Aug 89
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ARCCB-TR-89024	Optimization of Plating Parameters for Low Contraction Chromium Electrodeposits	S.K. Pan M.D. Miller F.J. Nelson	Oct 89
ARCCB-TR-89025	Determination of Sulfuric Acid in Anodizing and Hardcoating Solutions by Acid-Base Titration Using a pH Meter	S. Sopok	Oct 89
ARCCB-TR-89026	Determination of Iron in Chromium Plating and Polishing Solutions by Atomic Absorption Spectrometry	S. Sopok	Oct 89
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ARCCB-TR-89033	Modal Analysis of Nonprismatic Beams - Uniform Segment Method	R.G. Gast H.J. Sneck	Dec 89
ARCCB-MR-89034	Investigation Into the Fabrication of a Composite Top Attack Recoilless Rifle	K.R. Miner	Dec 89

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1. REPORT NUMBER: ARCCB-TR-89001

2. GOVT ACCESSION NO.:

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): MACHINE TOOL DYNAMIC MEASUREMENTS AND DIAGNOSTIC SYSTEM

5. TYPE OF REPORT & PERIOD COVERED: Final

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): R. K. Wharton and T. P. Vincent (See Reverse)

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Presented at the First Eastern Manufacturing Technology Conference, Springfield, MA, 10-12 November 1987.
Published in Proceedings of the Conference.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Machine Tools
Vibrations
Acquisition
Baselines
Dynamics
Preventive Maintenance
Spindles
Surfaces

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Vibrations in machine tools, commonly known as chatter, often are the cause for poor machining operations and breakdown of machinery. A state-of-the-art measurement and analysis system was designed, fabricated, and implemented. The system performs real-time acquisition of raw vibration measurement data and provides analysis for preventative/predictive maintenance action.

(CONT'D ON REVERSE)

7. AUTHORS (CONT'D)

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Watervliet, NY 12189-4050

20. ABSTRACT (CONT'D)

The system has been used to determine the causes for poor surface finishes occurring during metal removal processes. In the first case, during rough and finish grinding operations, several grinder spindles were found to be significantly out of balance. Investigation revealed that during balancing of spindles, the spindle manufacturer was using frequency versus mils engineering units to represent when a spindle was balanced. This procedure was found to be inadequate for the grinder's surface finish production requirement. The system's real-time capability resulted in the spindle manufacturer's redesign of his spindles and the acceptance of frequency versus g' level vibration units as more precise parameters to represent when a spindle balanced condition was present. In the second case, a surface grinder was producing poor surface finishes due to excessive vibration chatter attributed to spindle ball bearing outer race defects.

The implementation of the Machine Tool Dynamic Measurements and Diagnostic System into maintenance practices enables technological advantages in the following manufacturing areas: ability to quickly determine and remedy existing machine tool mechanical problems, reference-baseline vibration signature (newly acquired machine tools and existing units), assistance in maintaining ordnance dimensional and surface finish requirements, improvement in reducing machine downtime, and input for short/long-term management purposes.

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1. REPORT NUMBER: ARCCB-TR-89002	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): HIGH SPEED ABRASIVE BELT GRINDING	5. TYPE OF REPORT & PERIOD COVERED: Final
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Joseph Bak	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 3297.06.8024 PRON No. M7-2-F1857-M7-1A
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

High Speed Abrasive Belt Grinding
Coated Abrasives
Contact Wheel

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is the culmination of a two-phase project established to reduce current stock removal costs and eliminate finish turning operations of tubes by combining rough stock removal and finish grinding. The first phase was designated for engineering and investigation into the feasibility and application of abrasive belt grinding technology. This information was then used to generate a specification establishing some criteria for design and

(CONT'D ON REVERSE)

20. ABSTRACT (CONT'D)

manufacture of a machine to remove heavy stock and finish tubes utilizing abrasive belt technology. The specification was subsequently used for the acquisition of a machine to perform the tasks. The second phase was designated for testing of the equipment and establishing production parameters.

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1. REPORT NUMBER ARCCB-TR-89003	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ANALYSIS OF A LARGE HIGH PRESSURE VESSEL CLOSURE		5. TYPE OF REPORT & PERIOD COVERED Final
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7. AUTHOR(s) G. P. O'Hara		8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

Presented at the 1988 ASME Pressure Vessel and Piping Conference, Pittsburgh, PA, June 1988.
Published in Proceedings of the Conference.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Pressure Vessels
Stress
Contact
Screw Threads

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The design of the end closure for a high pressure vessel is never an easy task. However, in this case it is complicated by a requirement for quick operation and high reliability. The configuration which has best proven itself many times is the screw block breech. This report covers an analysis of this closure which is a five-body problem. The problem is further complicated by the fact that the bodies interact on eight contact surfaces. This analysis will point to a fatigue failure at a single point in the structural system.

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1. REPORT NUMBER: ARCCB-MR-89004	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): OVERVIEW OF ASTM SYMPOSIUM ON ANALYTICAL AND EXPERIMENTAL METHODS FOR RESIDUAL STRESS EFFECTS IN FATIGUE	5. TYPE OF REPORT & PERIOD COVERED: Final
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7. AUTHOR(s): R. L. Champoux, J. H. Underwood, and J. A. Kapp (see reverse)	8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

Published in ASTM STP 1004, Analytical and Experimental Methods for Residual Stress Effects in Fatigue.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Residual Stress
Fatigue
Pressure Vessels
Shot Peening
Fatigue Life

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An overview of the ASTM Symposium on Analytical and Experimental Methods for Residual Stress Effects in Fatigue, held on 20-21 October 1986 in Phoenix, Arizona, is presented. The background and objective for the symposium are described and the technical papers presented at the symposium and published in the proceedings are summarized. The papers are in two general categories: (1) effects of residual stress near the surface of a specimen or component--particularly shot peening applications, and (2) effects of bulk residual stresses--particularly autofrettaged pressure vessels and piping.

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7. AUTHORS (Cont'd)

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KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Chromium	Gun Tube
Adhesion	Cannon
Acoustic Emission	Chromium Loss

ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The use of acoustic emission was investigated as a method of characterizing chromium adhesion on steel. The samples used in the study were cylinders cut from the muzzle end of 120-mm gun tubes, plated on the inner surface with chromium, and cut to form split rings. Acoustic emission data was taken during loading of each ring. The results of the study are inconclusive regarding the effectiveness of acoustic emission as a test method for chromium adhesion.

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4. TITLE (and Subtitle) SWITCHING ZONE CONTROL FOR A SYSTEM WITH AN ELASTIC JOINT		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Ronald L. Racicot and Sheldon S.L. Chang (See Reverse)		8. CONTRACT OR GRANT NUMBER(s)
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Decentralized Control
Bang-Bang Control
Robotics
Flexible Mechanisms

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An extension of the powerful switching zone control (SZC) approach to include systems with elastic joints is presented. SZC is a decentralized non-linear feedback controller that approaches the minimum time bang-bang controller in the limit. The controller is robust and has a number of desirable attributes which are discussed in this report. The problems that are resolved in applying SZC to the flexible joint mechanism include stability, controller design, and nonzero steady-state disturbances. Simulation and experimental results demonstrate the usefulness of the developed procedures for practical applications.

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7. AUTHORS (Cont'd)

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4. TITLE (and Subtitle) PROPELLANT DRIVEN MHD GENERATOR FOR RAIL GUN POWER SUPPLY		5. TYPE OF REPORT & PERIOD COVERED Final Report May 86 - Sept 86 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Geoffrey W. Shuy and James T. Woo - InterScience, Inc. Patrick M. Vottis - Benet Laboratories		8. CONTRACT OR GRANT NUMBER(s) DAAA22-86-C-0267
9. PERFORMING ORGANIZATION NAME AND ADDRESS InterScience, Inc. 105 Jordan Road Troy, NY 12180		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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Patrick M. Vottis - Benet Laboratories Project Engineer

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Rail Guns
Electromagnetic Launchers
MHD Power Supply
Magnetohydrodynamic Power Supply
Propellant (Driven MHD)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A propellant driven magnetohydrodynamic (MHD) generator concept for pulsed power generation has been analyzed. The principal interest is to evaluate the feasibility of converting stored chemical energy to pulsed electrical energy for driving rail guns. The system requires neither electrical switching nor power conditioning and can be simple, lightweight, and reliable. Preliminary estimates of operating parameters have been made, including B-field, duct dimensions, current, power, overall efficiency, entrance and exit pressures, conductivities, and flow speeds.

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1. REPORT NUMBER ARCCB-TR-89008	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) WAVE COUPLING AND RESONANCE IN GUN TUBES		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) T. E. Simkins		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6111.02.H610.011 PRON No. 1A84Z8CANMSC
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army ARDEC Close Combat Armaments Center Picatinny Arsenal, NJ 07801-5000		12. REPORT DATE March 1989 13. NUMBER OF PAGES 21
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Presented at the Fifty-Ninth Shock and Vibration Symposium,
Albuquerque, NM, 18-20 October 1988.
Published in Proceedings of the Symposium.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Wave Motion in Solids
Vibrations
Resonance
Flexure

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Uncommonly large dynamic strains observed during the firing of a 120-mm gun tube have been found to be due to a projectile velocity which causes resonant type behavior of a particular axisymmetric wave. The theory explaining this phenomenon is reviewed and extended to show the potential for excitation of non-axially symmetric waves through coupling when the tube has an eccentric bore. These non-axially symmetric waves, one of which resonates at a projectile velocity extremely close to that which causes axisymmetric resonance, cause a beamlike motion of the gun tube which can affect accuracy at the target.

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1. REPORT NUMBER: ARCCB-TR-89009	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): TITANIUM-JACKETED CANNON TUBE PROGRAM	5. TYPE OF REPORT & PERIOD COVERED: Final
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): R. Hasenbein, E. Hyland, and G. Cunningham	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Army ARDEC, Benet Laboratories, SMCAR-CCB-TL, Watervliet, NY 12189-4050	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 6126.23.1BL0.0, PRON No. 1A82ZK24NMSC
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army ARDEC, Close Combat Armaments Center, Picatinny Arsenal, NJ 07806-5000	12. REPORT DATE: April 1989
	13. NUMBER OF PAGES: 84
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
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16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Titanium	Dynamic Strains	"Proof-of-Principle"
Titanium Alloy 38644	Autofrettage	Dispersion
Jacketed Cannon Tube	Residual Stresses	Fatigue
Shrink Fit	Pressure Vessel	Cannon Tubes

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A program has been completed in which a large caliber titanium-jacketed cannon tube was successfully designed, fabricated, and tested. The primary technical objective of this program was to reduce muzzle end weight, thereby lessening the tipping moment of the main weapon system.

The overall prupose of this report is to document the program efforts, so that it may be a reference for future concept programs.

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20. ABSTRACT (CONT'D)

Details are given concerning material properties, design requirements and rationale, fabrication methods, and test results.

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1. REPORT NUMBER ARCCB-TR-89010	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) SWITCHING ZONE CONTROL AS A DISTRIBUTED CONTROLLER		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Ronald L. Racicot and Sheldon S.L. Chang (See Reverse)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6111.02.H610.011 PRON No. A1826111A11A
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army ARDEC Close Combat Armaments Center Picatinny Arsenal, NJ 07806-5000		12. REPORT DATE April 1989 13. NUMBER OF PAGES 13
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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18. SUPPLEMENTARY NOTES

Presented at ISMM International Conference - Computer Applications in Design, Simulation, and Analysis, Reno, Nevada, 22-24 February 1989. Published in Proceedings of the Conference.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Decentralized Control
Bang-Bang Control
Robotics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report investigates the use of switching zone control (SZC) to control a multidegree of freedom robotic mechanism. Two powerful attributes of switching zone control are decentralization and near minimum time. The "decentralized" property allows the use of a distributed control system where each motor/joint of a multilink mechanism is independently controlled, for example, by its own microprocessor. Overall control can also be accomplished with another microprocessor which would coordinate overall motions and

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7. AUTHORS (CONT'D)

Sheldon S.L. Chang
State University of New York at Stony Brook
Department of Electrical Engineering
Stony Brook, NY 11794

20. ABSTRACT (CONT'D)

communications. The coupling effects from other links and motors as well as random valued gravity and friction effects are handled as disturbing torques. The newly investigated work reported here deals with: (1) experimental results and verification of applying SZC to a multidegree of freedom robotic system; (2) real-time identification of gravity, friction, and other effects to adaptively compensate for nonzero steady-state disturbing torques; and (3) extension of SZC to systems with elastic joints.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARCCB-MR-89011	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) DIMENSIONAL CHANGES IN WIRES DURING COILING OPERATIONS		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Boaz Avitzur		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6436.39.6430.012 PRON No. 4A7HF7YF/F1A
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army ARDEC Close Combat Armaments Center Picatinny Arsenal, NJ 07806-5000		12. REPORT DATE May 1989 13. NUMBER OF PAGES 15
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Coil Winding
Plastic Deformation
Dimensional Changes

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

When evaluating the properties of coils, either the magnetic field of an electromagnetic coil or the spring-constant of a coiled spring, it is common to assume that the wire's cross section remains the same as in its linear form. In reality, however, changes in this cross section become more pronounced as the ratio of the wire's thickness, H, (in the radial direction of the coil) to that of the coil's inner diameter, ID, approaches 0.05 and above. While these changes are functions of the above-mentioned ratio, they
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20. ABSTRACT (CONT'D)

vary between the coil's ID and its outer diameter, OD. In designing coils for high current density, the ability to compute these changes becomes pertinent, mainly because it affects the minimum available clearance between the coil's loops.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARCCB-TR-89012	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ADVANCED TANK GUN PARAMETRIC STUDY (U)		5. TYPE OF REPORT & PERIOD COVERED Final Report Dec 1986 - Nov 1987 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Steven L. Morris		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6126.23.1BL0.0AR PRON No. 1AZ22J58NMSC
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army ARDEC Close Combat Armaments Center Picatinny Arsenal, NJ 07806-5000		12. REPORT DATE May 1989 13. NUMBER OF PAGES 37
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Tank Guns
Kinetic Energy Penetrators
Interior Ballistics
Chemical Energy Warheads

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The study was performed in order to determine what characteristics would be desirable in future tank guns. The future was defined as the 2005-2010 time frame. Consideration was given to physical parameters, such as length of travel, chamber volume, etc.; to current and projected areas of ammunition development; and to projected threats for the time frame under consideration. Due to the nature of the role of tank guns, the analysis of kinetic energy projectiles is given the primary emphasis, although secondary rounds are

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20. ABSTRACT (CONT'D)

considered. A configuration for future tank guns is proposed, and several suggestions for future work are made.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARCCB-SP-89013	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) INDEX TO BENET LABORATORIES TECHNICAL REPORTS - 1988		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. D. Neifeld		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS N/A
11. CONTROLLING OFFICE NAME AND ADDRESS US Army ARDEC Close Combat Armaments Center Picatinny Arsenal, NJ 07806-5000		12. REPORT DATE May 1989 13. NUMBER OF PAGES 109
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Benet Laboratories
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Abstracts
Document Control Data

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is a compilation of technical reports published by Benet Laboratories during 1988.

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1. REPORT NUMBER ARCCB-TR-89014	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) STRESS INTENSITY FACTORS AND DISPLACEMENTS FOR ARC BEND SAMPLES USING COLLOCATION		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. A. Kapp		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 612105.H840011 PRON No. 1A62ZH7CNMSC
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army ARDEC Close Combat Armaments Center Picatinny Arsenal, NJ 07806-5000		12. REPORT DATE June 1989 13. NUMBER OF PAGES 25
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18. SUPPLEMENTARY NOTES

Presented at the Eighteenth ASTM National Symposium on Fracture Mechanics, Boulder, Colorado.
Published in Proceedings of the Symposium.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Fracture Mechanics
Fracture Toughness Testing
Boundary Collocation
Arc-Shaped Fracture Toughness Specimens

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Stress intensity factors, crack mouth opening displacements, and load-line displacements were determined for the arc bend-chord support specimen using boundary collocation. Several inner radius (r_1) to outer radius (r_2) ratios were studied at each of two span (S) to width (W) ratios. The actual solution matrix is for S/W = 3, r_1/r_2 = 0.8, 0.6, 0.4, and for S/W = 4, r_1/r_2 = 0.8, 0.7, 0.6. Also, the three-point bend single-edge specimen (SE(B)) at both S/W = 3 and S/W = 4 was studied to examine the limiting behavior of the

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20. ABSTRACT (CONT'D)

generated solutions. For all of the S/W = 3 cases, solutions were obtained for crack length to width ratios (a/W) from 0.2 to 0.6, and in the S/W = 4 cases, a/W was varied from 0.2 to 0.5. The solutions were obtained by the linear superposition of a pure bending stress, a pure shear stress, and a uniform normal stress on an annular segment. The magnitudes of the individual components depended upon the size of the annular segment and the S/W ratio. Wide range expressions were fit to the numerical solutions to make them applicable over a wider range of testing conditions and for inclusion in future revisions of E-399 on Plane-Strain Fracture Toughness Testing.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARCCB-MR-89015	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) REPORT ON THE DEVELOPMENT OF NONDESTRUCTIVE TESTING CRITERIA FOR THE 120-MM XM830 PROJECTILE BODY		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. A. Rapp and R. T. Abbott		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 7280.12.1200.00 PRON No. 1A52NZMZ1A1A
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army ARDEC Close Combat Armaments Center Picatinny Arsenal, NJ 07806-5000		12. REPORT DATE June 1989 13. NUMBER OF PAGES 17
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16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

M830
HEAT Rounds
Projectiles
Fracture
Nondestructive Testing

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The nondestructive testing defect criteria for the 120-mm M830 HEAT round have been developed. Based on a finite element stress analysis of launch stresses performed at ARDEC, an estimated stress intensity factor (K) solution has been determined. Fracture toughness measurements on several M830 projectile bodies are made to determine the range of fracture properties that are expected in large production of this component. The limiting sizes of allowable defects are determined by combining the K solution with the fracture toughness

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20. ABSTRACT (CONT'D)

measurements. Although no statistical analysis is performed, no launch failures of the M30 due to material defects are anticipated during its expected useful life because of the liberal safety factors used along with conservative assumptions and engineering judgment.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARCCB-TR-89016	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FRACTURE AND THREE-DIMENSIONAL STRESS ANALYSES OF 7075 ALUMINUM PROJECTILE COMPONENTS UNDER SPIN AND INERTIA LOAD		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. H. Underwood, M. A. Scavullo, G. P. O'Hara, and B. A. Konrad (See Reverse)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6111.01.91A0.000 PRON No. 1A7BZ701NMSC
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army ARDEC Close Combat Armaments Center Picatinny Arsenal, NJ 07806-5000		12. REPORT DATE June 1989 13. NUMBER OF PAGES 20
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Materials Research Laboratories Defence Science and Technology Organisation P.O. Box 50, Ascot Vale Victoria, 3032, Australia		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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18. SUPPLEMENTARY NOTES

Portions of this work were performed at Materials Research Laboratories, Australia. Presented at the 1987 Symposium of the Australian Fracture Group, University of Sydney, 24-25 August 1987. Published in Proceedings of the Symposium.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Stress Analysis	Failure Energy
Fracture Mechanics	High Strength Aluminum
Finite Elements	Armament Components

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A fracture case study of a high strength aluminum projectile component subjected to inertial and spin loading during launch from a cannon is presented. A three-dimensional finite element model was used to calculate the projectile stresses and to determine which of the several types of loading was the primary cause of failure. A design change to minimize spin loading resulted in a significantly reduced failure incidence. Mechanical and fracture mechanics tests of the aluminum were performed in order to determine material

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7. AUTHORS (Cont'd)

B. A. Konrad
U.S. Army ARDEC
Close Combat Armaments Center
Tank Ammunition Branch B
Picatinny Arsenal, NJ 07806-5000

20. ABSTRACT (Cont'd)

specifications which could prevent failures in the future. An energy-to-failure test similar to the Charpy test was found to be the most discriminating.

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1. REPORT NUMBER: ARCCB-TR-89017	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): COMPRESSION MOLDING OF FIBER GLASS/EPOXY HANDGUARDS FOR THE SFLM ADVANCED COMBAT RIFLE	5. TYPE OF REPORT & PERIOD COVERED: Final
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Kevin R. Miner	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Army ARDEC, Benet Laboratories, SMCAR-CCB-TL, Watervliet, NY 12189-4050	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 6236.07.6270.0, PRON No. 1A-8-3Z8CD-NMSC
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army ARDEC, Close Combat Armaments Center, Picatinny Arsenal, NJ 07806-5000	12. REPORT DATE: July 1989
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14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Advanced Combat Rifle	Compression Molding
Fiber Glass/Epoxy Composites	Composites Fabrication
Composite Materials	Filament Winding

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A novel compression molding process was used to fabricate a lightweight, high-strength continuous filament fiber glass/epoxy handguard for the advanced combat rifle. This process involved placing a filament wound preimpregnated preform into a fiber glass/epoxy mold with a room temperature vulcanized (RTV) rubber top cover and subjecting it to an autoclave cycle. A well-compacted and durable structure was easily and quickly produced utilizing this technique.

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1. REPORT NUMBER ARCCB-TR-89018	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) APPLICATIONS AND LIMITATIONS OF FINITE ELEMENT ANALYSIS TO ARMAMENT COMPONENTS		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. H. Underwood		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6126.24.1BL0.0AR PRON No. 1A72ZH7QNMSC
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army ARDEC Close Combat Armaments Center Picatinny Arsenal, NJ 07806-5000		12. REPORT DATE July 1989 13. NUMBER OF PAGES 22
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18. SUPPLEMENTARY NOTES

Presented at the Fifth International Conference in Australia on Finite Element Methods, University of Melbourne, 19-21 August 1987. Published in Proceedings of the Conference.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Finite Elements
Fracture Mechanics
Stress Analysis
Armament Components
Fracture Tests
Fatigue
Notch Stress

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A review of three applications of finite element methods for stress, displacement, and stress intensity factor analyses of various armament components is presented. First, stress analysis of sections from outside diameter notched cylinders was performed to describe the cylinder's fatigue life behavior. Second, stress analysis methods for long rod projectiles subjected to inertial loading were developed; the stresses at a failure location of a projectile were used to help explain the failure and were related to results of mechanical

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20. ABSTRACT (CONT'D)

tests of the projectile and the projectile material. Last, stress intensity factor and displacement analyses of fracture mechanics test specimens were performed to recommend standardized test procedures. Stress intensity factor and load-line displacement solutions were obtained for three-point bend, arc-shaped specimens which can be conveniently cut from cylindrical vessels and pipes. The finite element solutions were compared with collocation solutions for the same and similar geometries.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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4. TITLE (and Subtitle) AUTOFRETTAGE--STRESS DISTRIBUTION UNDER LOAD AND RETAINED STRESSES AFTER DEPRESSURIZATION		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Boaz Avitzur		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6436.39.6430.012 PRON No. 4A7HF7YF/F1A
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Presented at informal discussions with representatives of industry and academia at industrial and educational facilities in Israel between 29 November and 21 December 1988.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Autofrettage	Tresca's Yield Criterion
Thick-Walled Tubes	Mises' Yield Criterion
Stress Distribution	Plane-Stress
Retained Stresses	Plane-Strain

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

There is a long-standing interest in developing a capability to predict the distribution of retained stresses in thick-walled tubes after the removal of an internal pressure--post autofrettage. In this report, four different methods of calculating such stresses are presented and compared. The methods presented are based on the following assumed yield criteria and deformation conditions:

(Cont'd on Reverse)

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20. ABSTRACT (CONT'D)

1. Tresca's yield criterion
2. Tresca's yield criterion times $2/\sqrt{3}$
3. Mises' yield criterion in plane-stress
4. Mises' yield criterion in plane-strain

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARCCB-TR-89020	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* THE INFLUENCE OF TRANSIENT FLEXURAL WAVES ON DYNAMIC STRAINS IN GUN TUBES		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR*(s)* Thomas E. Simkins		8. CONTRACT OR GRANT NUMBER*(s)*
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6111.02.H610.0 PRON No. 1A94Z9CANMSC
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Waves
Wave Propagation
Transient Vibrations
Steady-State Vibrations
Flexural Vibrations of a Cylinder

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Transient waves or vibrations can be excited in several ways as ballistic pressure traverses the length of a gun tube. This report shows that despite their diversity, these transients will constructively interfere with the steady-state deformation in a highly predictable way to cause alternating regions of high circumferential strain along the tube. The method of stationary phase plays a key role in the analysis.

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1. REPORT NUMBER ARCCB-TR-89021	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EFFECTS OF VARYING PLATING PARAMETERS ON THE LONGITUDINAL DISTRIBUTION OF LOW CONTRACTION CHROMIUM IN LONG GUN TUBES		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John C. Askew		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6126.23.1BL0.0AR PRON No. 1A72RZVENMSC
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Low Contraction Chromium
Critical Length
Taper
Reynolds Number
Linear Regression

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is a quantitative description of the effects of varying flow rate, plating time, and anode spacing on the deposition of low contraction chromium in long gun tubes. Linear regression is used to develop a model which relates the relevant plating parameters. The limited data yield results specifically applicable to 155-mm rifled tubes in lengths of 300 inches or less.

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1. REPORT NUMBER ARCCB-TR-89022	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) DETERMINATION OF CHROMIC ACID IN CHROMIUM PLATING SOLUTIONS USING A REDOX TITRATION AND INDICATOR		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Samuel Sopok		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6126.23.1BL0.0 PRON No. 1A92ZNACNMSC
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18. SUPPLEMENTARY NOTES

Submitted to Plating and Surface Finishing.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Chemical Analysis
Chromic Acid
Chromium Plating Solutions
Redox Titration
Redox Indicator

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The chemical literature lacks a simple analytical method for adequately controlling chromic acid in chromium plating solutions during the plating process. In this report, a simple method for analyzing and controlling chromic acid during the plating process is presented. The optimum operating range of chromic acid is 240 to 260 g/l and the resulting precisions are in the range of 0 to 2.5 g/l, providing adequate control of these plating solutions supported by five years of testing.

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1. REPORT NUMBER ARCCB-TR-89023	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ANALYTICAL COMPARISON OF THE ACCURACY OF TANK WEAPONS		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Ronald G. Gast		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6126.23.1BL0.0 PRON No. 1A92ZPH5NMLC
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Tank Weapons	Non-uniform Beams
Gun Dynamics	Accuracy
Vibrations	Modal Analysis

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Contemporary military strategists emphasize the importance of increased mobility, lethality, and survivability for battle tanks earmarked for the twenty-first century. This impels the developers of tank armament to deliver lighter cannons which are more lethal yet less vulnerable than their predecessors. Therefore, vibration and its impact upon shot accuracy as well as strength must be considered in the design of current lightweight tank guns.

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20. ABSTRACT (CONT'D)

The Uniform Segment Method (USM) is a modal analysis technique for determining the transient vibration response of large caliber weapons driven by the classical gun/beam loads. It was devised for use in the design loop of new tank weapons. In this report, the accuracy of tank armament in development is compared to the fielded systems which they replace. A number of new design features which have been incorporated into the design are addressed in regard to their impact upon shot accuracy.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARCCB-TR-89024	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) OPTIMIZATION OF PLATING PARAMETERS FOR LOW CONTRACTION CHROMIUM ELECTRODEPOSITS		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) S. K. Pan, M. D. Miller, and F. J. Nelson		8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Chromium
Plating
Low Contraction
Crack-Free

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Electrodeposition of low contraction (LC) chromium has been investigated in order to deposit a high tensile strength and crack-free chromium coating. The plating parameters--current density, chromic acid/sulfuric acid ratio, and chromium(III) concentration--were varied and a systematic study was performed. A chromic acid concentration of 250 g/l and a bath temperature of 85°C were maintained constant throughout the study. The deposit is crack-free having a typical columnar microstructure of fibrous grains with a <211> preferred

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20. ABSTRACT (CONT'D)

orientation. On the basis of mechanical properties of the deposits, optimum plating conditions were found, i.e., 97 A/dm^2 current density, 100/1 acid ratio, and 4.0 g/l chromium(III) concentration. With the optimum plating conditions, a tensile strength of 87,000 psi and hardness of 760 KHN were obtained from the deposit.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
PORT NUMBER CCB-TR-89025	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
TLE (and Subtitle) TERMINATION OF SULFURIC ACID IN ANODIZING AND RDCOATING SOLUTIONS BY ACID-BASE TITRATION ING A pH METER		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
THOR(s) muel Sopok		8. CONTRACT OR GRANT NUMBER(s)
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SUPPLEMENTARY NOTES

Submitted to Plating and Surface Finishing.

KEY WORDS (Continue on reverse side if necessary and identify by block number)

Chemical Analysis
Sulfuric Acid
Anodizing Solutions
Hardcoating Solutions
Aluminum Finishing Solutions
Acid-Base Titration
pH Meter

ABSTRACT (Continue on reverse side if necessary and identify by block number)

The chemical literature lacks an acceptable analytical method for adequately monitoring sulfuric acid in aluminum finishing solutions during the finishing processes. These solutions include anodizing and hardcoating solutions. In this report, an improved method is presented that provides acceptable analysis and monitoring of this acid during the finishing processes. The optimum operating ranges of this acid are 90 to 150 g/l and 120 to 150 g/l for the respective anodizing and hardcoating solutions. The resulting precisions are

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20. ABSTRACT (CONT'D)

in the range of 1 to 3 g/l, providing adequate monitoring of these metal finishing solutions supported by seven years of testing.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARCCB-TR-89026	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* DETERMINATION OF IRON IN CHROMIUM PLATING AND POLISHING SOLUTIONS BY ATOMIC ABSORPTION SPECTROMETRY		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Samuel Sopok		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6126.23.1BL0.0 PRON No. 1A92ZNACNMSC
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18. SUPPLEMENTARY NOTES Submitted to Plating and Surface Finishing.		
19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)* Chemical Analysis Iron Chromium Plating Solutions Polishing Solutions Atomic Absorption Spectrometry		
20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)* The chemical literature lacks a specific analytical method for adequately monitoring iron in chromium plating and polishing solutions during the plating and polishing processes. In this report, a specific method is presented for analyzing and monitoring iron during these processes. The optimum operating range of the iron is generally around 10 g/l maximum in both the chromium plating and the polishing solutions. The resulting precisions are in the range of 0.5 to 1.5 g/l, providing adequate monitoring of these solutions supported by six years of testing.		

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1. REPORT NUMBER ARCCB-TR-89027	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* ELASTIC-PLASTIC ANALYSIS OF A THICK-WALLED COMPOSITE TUBE SUBJECTED TO INTERNAL PRESSURE		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Peter C. T. Chen		8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

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Published in Proceedings of the Conference.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Composite Jacket
Steel Liner
Elastic-Plastic Analysis
Thick-Walled Tube

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report presents an elastic-plastic analysis of a thick-walled composite tube subjected to internal pressure. The composite tube is constructed of a steel liner and a graphite-bismaleimide outer shell. Analytical expressions for stresses, strains, and displacements are derived for all cases where the structure is subjected to internal pressure. The loading ranges include elastic, elastic-plastic, and fully-plastic up to failure. Numerical results for the hoop strains in several composite tubes are presented.

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1. REPORT NUMBER ARCCB-TR-89028	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THERMAL STUDY OF THE 120-MM M256 CANNON TUBE		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) B. Artus and R. Hasenbein		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6126.23.1BL0.0 PRON No. 1A82ZK24NMSC
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

M256 Thermal Data
M256 Thermal Model
M256 Chamber Temperatures
M256 Cook-Off Potential

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents thermal data recently obtained during tests of the 120-mm M256 cannon tube firing DM13 APFSDS-T ammunition. A thermodynamic model has been calibrated which predicts tube temperatures using direct input from an interior ballistics code. Predictions have also been made (using the calibrated model) of worst-case temperatures expected when firing various types of 120-mm ammunition (DM13 APFSDS, M829 APFSDS, M829E1 APFSDS, and M830 HEAT) from this cannon.

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20. ABSTRACT (CONT'D)

Temperature predictions generated in this study should be adequate for assessing whether various ammunition components loaded into a hot 120-mm M256 cannon tube will experience problems such as autoignition (i.e., cook-off) or other thermal effects.

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1. REPORT NUMBER ARCCB-TR-89029	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) DOES ABSENCE OF SATURATION PRECLUDE STRONG ELECTRON-PHONON COUPLING?		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) L. V. Meisel		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army ARDEC Benet Laboratories, SMCAR-CCB-TL Watervliet, NY 12189-4050		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6111.02.H610.11 PRON No. 1A82Z8CANMSC
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18. SUPPLEMENTARY NOTES

Published in Journal of Physics: Condensed Matter, Vol. 1, 1989, pp. 817-822.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Superconductivity
Electron-Phonon Interaction
Saturation
Electrical Transport

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Diffraction model calculations of electrical resistance for strong electron-phonon coupling in two- and three-dimensional alloys incorporating Pippard-Ziman phonon ineffectiveness are reported. It is shown that in an electron-phonon scattering-based theory, although strong electron-phonon coupling is necessary, it is not a sufficient condition for the production of strong saturation in the normal state resistivity. Thus, absence of saturation does not preclude strong electron-phonon coupling.

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1. REPORT NUMBER ARCCB-TR-89030	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) DETERMINATION OF TRIVALENT CHROMIUM IONS IN CHROMIUM PLATING SOLUTIONS BY ULTRAVIOLET-VISIBLE SPECTROPHOTOMETRY		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Samuel Sopok		8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

Submitted to Plating and Surface Finishing.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Chemical Analysis
Trivalent Chromium Ions
Cr(III) Ions
Chromium Plating Solutions
UV-Visible
Spectrophotometry

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The chemical literature lacks a specific and direct analytical method for adequately monitoring trivalent chromium ions (Cr(III)) in chromium plating solutions during the plating process. In this report, a specific and direct method is presented providing acceptable analysis and monitoring of the trivalent chromium in this process. The optimum operating range of the trivalent chromium is 7.5 g/l maximum in the chromium plating solutions. The resulting precisions are in the range of 0.5 to 1.0 g/l, providing adequate monitoring of these solutions supported by four years of testing.

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4. TITLE (and Subtitle) DETERMINATION OF PHOSPHORIC AND SULFURIC ACIDS IN POLISHING SOLUTIONS BY ACID-BASE TITRATION USING A pH METER		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Samuel Sopok		8. CONTRACT OR GRANT NUMBER(s)
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Chemical Analysis
Phosphoric Acid
Sulfuric Acid
Alloy Steel Polishing Solutions
Chromium Plating
Acid-Base Titration
pH Meter

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The chemical literature lacks an acceptable analytical method for adequately monitoring phosphoric and sulfuric acids in alloy steel polishing solutions during the polishing process. In this report, an improved method is presented that provides acceptable analysis and monitoring of these acids. The typical operating ranges of these acid constituents are 640 to 730 g/l phosphoric acid and 795 to 895 g/l sulfuric acid. The resulting precisions are in the range of 0 to 8 g/l, providing adequate monitoring of these polishing solutions supported by six years of testing.

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7. AUTHOR(s) Philip C. Wheeler		8. CONTRACT OR GRANT NUMBER(s)
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Braiding
Composite
Resin Applicator System
Fiber-Volume Fraction

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Braiding is a process in which fibrous strands of material are interlocked and precisely placed onto a mandrel. Resin may be applied to the fibers prior to placement onto the mandrel through a resin applicator.

Certain parameters are needed in the braiding process for the operator to fabricate an item displaying specific properties. Some of these parameters are braider speed, mandrel traverse rate, and volume flow rate of the resin and

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20. ABSTRACT (CONT'D)

the fiber onto a mandrel.

Descriptions and calculations of these parameters are covered in this report.

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7. AUTHOR(s) Ronald G. Gast and H. J. Sneck (See Reverse)		8. CONTRACT OR GRANT NUMBER(s)
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Modal Analysis
Beam Vibration
Vibration
Structural Dynamics
Numerical Methods

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A method to determine the free vibration frequencies and mode shapes of non-prismatic beams that are end-mounted on various supports is described. The term Uniform Segment Method (USM) is used to distinguish this method from finite element (FEM) techniques. The analytical details are presented along with a description of the implementing computer routines. The results are compared with finite element models. Directions for continued research using this modelling technique are also outlined.

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Recoilless Rifle
Graphite/Epoxy Composites
Composite Materials
Composite Fabrication
Filament Winding
Braiding

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The fabrication of a lightweight, expendable recoilless rifle, known as TOPCAT (Top Attack Consumable Antitank), using composite materials was investigated. Filament winding and braiding were successfully employed in the construction of several of these shoulder-fired weapons.

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